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A PROPOSED NOMENCLATURE FOR THE PARTS OF THE POSTERIOR RESPIRATORY APPARATUS OF DIPTEROUS LARVÆ AND A MICRO-PROTRACTOR USEFUL IN THEIR DESCRIPTION.[1]

By C. L. Metcalf

It has been pretty generally recognized that the most serviceable diagnostic character for the specific determination of Dipterous larvæ of certain families is the posterior respiratory apparatus, which varies endlessly in the different genera and species, but appears to be very constant within the species. So superior are the characteristics drawn from this part of the larva, that I regard most descriptions which omit consideration of them as practically worthless. For in most cases the general features of shape, color, etc., may be found to apply almost equally well to other species. The most available, absolutely diagnostic characters are to be found on the posterior stigmata.

This apparatus consists, in many species, of three pairs of spiracles, generally more or less elongate or linear, and a fourth pair of circular structures (usually present) referred to in literature as "buttons" or "circular plates."[2] This respiratory organ varies in the different families, genera and species in height; in width; in extent of elevation above the surface of the segment which bears it; in the ornamentation of the interspiracular spaces (*vide infra*); in length and width of the slit-like spiracles, which may be straight, curved, sinuate or denticulate, and variously arranged with respect to the median line and to each other; in the presence or absence of the circular plate, its position and diameter; and in many other ways.

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[1] Contributions from the Entomological Laboratory of the Bussey Institution, Harvard University, No. 160.

[2] In those rarer cases (as *e. g.*, *Œstris ovis*) where the three pairs of spiracles appear to be wanting, only a part of the following characteristics will be found to be applicable.

The need of a satisfactory and uniform nomenclature of these parts is evident. Mr. Nathan Banks,[1] Mr. M. E. MacGregor,[2] and Professor W. B. Herms,[3] especially, have emphasized the value of these structures with reference to the larvæ concerned in myiasis; the writer[4] has for several years been applying this method to the larvæ of Syrphidæ; and indeed many investigators in recent years, have recognized the necessity of figuring the stigmal plates of the larvæ described in a number of Dipterous families. I have no doubt that many of the groups of amphineustic larvæ can be specifically diagnosed in the same way. In the various publications touching on this subject a variety of terms have been used. It is with the hope of acquiring uniformity of terminology in the various groups and by subsequent investigators that I have herein compiled and described such of these terms as have come to my attention.[5]

The spiracles, together with the adjacent surface of the segment which bears them are called *the stigmal field.* The right and left halves of the respiratory organ, which are especially heavily chitinized, are each called a *stigmal plate.* The diagnostic points of chief importance, so far as my observations have gone are as follows:

(1) *Whether the stigmal plates are sessile* on the caudal surface of the last segment, *or stalked, i. e.*, elevated at the end of a shorter or longer (sometimes tremendously elongate) tube.

(2) *Whether the two stigmal plates are contiguous or separated.*

(3) *If separated, the distance between the plates:* the minimum transverse distance intervening. (MacGregor, Herms.)

(4) *If stalked, or sessile and contiguous, the width of the posterior respiratory organ:* the maximum transverse measurement from lateral margin of one stigmal plate to lateral margin of the other.

(5) *If separated, the width of one stigmal plate* may be more satis-

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[1] Banks, N., The structure of Certain Dipterous Larvæ with special reference to those in Human Foods, Bull. U. S. Dept. Agr. Tech. Ser. 22, Jan. 10, 1912.

[2] MacGregor, M. E., The Posterior Stigmata of Dipterous Larvæ as a Diagnostic Character: with Especial Reference to the Larvæ Incriminated in Cases of Myiasis; In Parisitology, Vol. VII, No. 2, June 19, 1914, pp. 176–188, 3 ppl.

[3] Herms, W. B., Medical and Veterinary Entomology, The Macmillan Co., 1915, pp. 259, 260.

[4] Metcalf, C. L., The Syrphidæ of Ohio, Ohio Biol. Sur. Vol. I, Bul. 1, June, 1913; Me. Agr. Exper. Sta. Bul. 253, Oct. 1916; and do Bul. 263, Oct. 1917.

[5] I am indebted to Professor Charles T. Brues for assistance with the literature on this subject.

factorily used, and in this case the easiest measurement to make appears to be the maximum, strictly transverse diameter.[1]

(6) *If stalked, the length of the posterior respiratory organ or tube:* the elevation of the stigmal plates above the general surface of the segment which bears them.

(7) *The height of the stigmal plate or respiratory organ:* the maximum dorso-ventral (sometimes apparently cephalo-caudal) measurement.

(8) *The presence or absence of the circular plate or button.* (Banks.)

(9) *The position of the button, whether on the circumference of the stigmal plate* ("ring" of MacGregor) *or within it.* (MacGregor.)

(10) *The diameter of the circular plate or button:* a strictly transverse measurement through its center.

(11) *The distance between the mesal margins of the two circular plates.*[2]

(12) *The length of the slit-like spiracles.*

(13) *The width of the spiracles.*

(14) *The shape of the spiracles,* which are for convenience of further description named dorsal, median and ventral. It is necessary to note that the several spiracles on the same stigmal plate may vary greatly in shape and it is often necessary to refer specifically to them.[3] See figure 1.

(15) *The ornamentation of the stigmal plate* with spines, tubercles,

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[1] Professor Herms (*loc. cit.*) has used "the diameter of the stigmal plate, the space occupied by one stigmal plate on a line drawn through the center of both; (2) length, when slits are absent, the space occupied by a plate on a line drawn dorso-ventrally through the center of the plate; or when slits are present the space occupied by a plate along a line drawn from the lower edge of button (or space if button is absent) through the longest slit (middle slit) to the margin of the plate; (3) width, along a line drawn at the middle of the plate at right angles to the length line." These are so defined as to be a little difficult to measure,—requiring an estimation of such features as "the center of the plate," and a line at right angles to another. They are to this extent apt to lead to error, and will, I believe, be adequately supplanted by the more readily determinable features suggested above in paragraphs 5 and 7.

[2] MacGregor suggests measuring from center to center of buttons, which complicates the matter by necessitating an estimation of the central point of each plate. Point 11, in connection with point 10 will give the same result more easily.

[3] MacGregor (*loc. cit.*) attempts to divide the forms of posterior stigmata into two main types: the *schizotreme*-type especially characterized by possessing three pairs of slit-like spiracles; and the *ptychotreme*-type, possessing instead "a convoluted chain" (*e. g.*, *Musca domestica*, *Stomoxys calcitrans*, *Hæmatobia serrata*, etc.). But he, himself, points out that there are usually two ("three," *loc. cit.*, p. 181) breaks in the chain. I think there is no sound basis for such distinction. Both of these forms have three pairs of spiracles; the convoluted spiracle and the slit-like one are fundamentally homologous, differing only in shape; and all possible intermediate grades of convolution and complexity are to be found. In cases of very great complexity, it is true, the spiracles may run together so that it is difficult to determine the limits of each, but I believe such forms have the same origin.

carinæ, simple, branched or plumose hairs, etc. This ornamentation arises usually between the spiracles, and for descriptive purposes, I have numbered these inter-spiracular *spaces*, 1, 2, 3, and 4, beginning with the one mediad of the dorsal spiracle. See figure 1.

(16) *The nature of the delicate chitinous bars crossing the slit-like spiracles* (MacGregor); a point undoubtedly of very great importance, but in many species too difficult of determination to be practically useful.

(17) *The nature of the chitinous ring surrounding the stigmal plate;* whether heavy or light, complete or incomplete; the last condition usually associated with the absence of the button or circular plate (MacGregor).

The most casual student could not but note the great diversity in position of the slit-like spiracles with reference to each other and to the median line of the body. Banks uses in his synopsis of the groups (*loc. cit.*, p. 15) such characters as "slits arranged radially," or "sub-parallel to each other" or "rather transverse to body." MacGregor mentions "the orientation of the stigmata with reference to the . . . longitudinal axis of the larva" and the position of the slits with respect to each other and to the median sagittal plane of the body.

But, so far as I am aware, no attempt has hitherto been made to use for specific description

(18) *The accurately-measured angle of divergence between the several spiracles*, and

(19) *Their divergence from the median line.*

However, from my observations in the Syrphidæ and myiasis-causing species, I am convinced that much more can profitably be made of these points; and in the case of very closely related species, I believe this may at times prove to be the only reliable means of separation. These characters are, of course, available only in those cases where the spiracles are straight, or nearly so, so that their main longitudinal axis is readily determinable.

I was much surprised, when I conceived the notion of using this method of description, that I was unable to find anywhere on the market the apparatus by which such angular measurements could readily be made under the microscope. I finally designed a *micro-protractor*,[1] for use in the ocular of the microscope, by means of which it is very easy to gauge the angle of divergence of these parts. The micro-protractor (see figure 2) is a simple glass disk, 21 mm. in diameter, ruled in angles so designed and arranged that by using different combinations of adjacent larger and smaller angles as indicated by the concentric lines in figure 2, it is possible to measure very accurately any angle from 5° to 360° by 5° intervals. Even single degrees of divergence may be estimated with considerable accuracy by this method.

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[1] Made by The Bausch & Lomb Optical Co., Rochester, N. Y., who guaranteed its accuracy to within half a degree.

In order to use these points it is only necessary to place the quiescent (killed or paralyzed) larva or the puparium under the microscope in such position that the plane of the stigmal plates is perpendicular to the axis of vision. The ocular with the micro-protractor resting on its diaphragm is then revolved until some combination of its measured angles exactly coincides with the angle of divergence of the spiracles to be measured.[1]

The amount of divergence of the dorsal spiracles from each other I have called *angle A* (See figure 1). In cases where the two stigmal plates are widely separated it may be easier to measure the divergence of either dorsal spiracle from the median line and this may be designated $\frac{angle\ A}{2}$. The amount of divergence between the dorsal and median spiracles on either side is *angle B:* that between the median and ventral spiracles on either side is *angle C;* and that of the right and left ventral spiracles from each other is *angle D*. Here again the divergence of a ventral spiracle from the median line may be designated $\frac{angle\ D}{2}$. *In all cases where the outer (peripheral) ends of two spiracles are closer together than their inner (central) ends, the fact is indicated by designating the corresponding angle a minus one.* This is often the case with *angles A* and *D* in the Syrphidæ.

In addition to its use as described above, I believe the micro-protractor may prove useful to biologists in many lines of work where it is desired to measure the angles of microscopic objects.

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[1] Whenever it is possible to do so, much better results will be achieved by preparing the stigmal plates with 10 per cent KOH solution, as described by MacGregor and Herms in the papers cited above.

Explanation of Plate I.

Fig. 1. Diagrammatic figure of the posterior respiratory organ of a dipterous larva indicating the several diagnostic characters. *Diameter of circular plate. 1, 2, 3, 4, first, second, third and fourth interspiracular spaces of left stigmal plate. I, II, III, dorsal, median and ventral slit-like spiracles, respectively, of right stigmal plate. IV, the left circular plate or "button."

Fig. 2. The micro-protractor showing arrangement of ruled angles. The various possible combinations from 5° to 360° indicated by the concentric lines.

A PHYLOGENETIC STUDY OF THE MESOTHORACIC TERGA AND WING BASES IN HYMENOPTERA, NEUROPTERA, MECOPTERA, DIPTERA, TRICHOPTERA AND LEPIDOPTERA.[1]

By G. C. Crampton, Ph.D.

In several papers dealing with the phylogeny of insects, the Hymenoptera, Neuroptera, Mecoptera, Diptera, Siphonaptera, Trichoptera, Lepidoptera and their allies were grouped in a superorder called the "*Panneuroptera.*" A portion of the evidence for such a grouping, based upon the study of the genitalia of males, has already been presented in Psyche, Vol. 25, p. 47, and in the Proc. Ent. Soc. Washington, Vol. 21; and in the present paper, I would briefly review the evidences of relationships indicated by the nature of the mesothoracic terga and wing bases in these insects. The terminology here adopted is that previously applied to the terga and wing bases of the Embiidæ, Plecoptera, Coleoptera and Dermaptera (Psyche, Vol. 25, p. 4), the Blattidæ, Plecoptera and Neuroptera (Jour. N. Y. Ent. Soc., Vol. 24, p. 1), the Orthoptera (Ann. Ent. Soc. America, Vol. 11, p. 347), and the Hymenoptera and Diptera (Jour. N. Y. Ent. Soc., Vol. 22, p. 248).

In the lower insects, the metathorax is subequal in size to the mesothorax, and in a few instances is even larger than the mesothorax. In the insects here considered, however, the mesothorax is usually the larger of the two, and since the metathorax becomes

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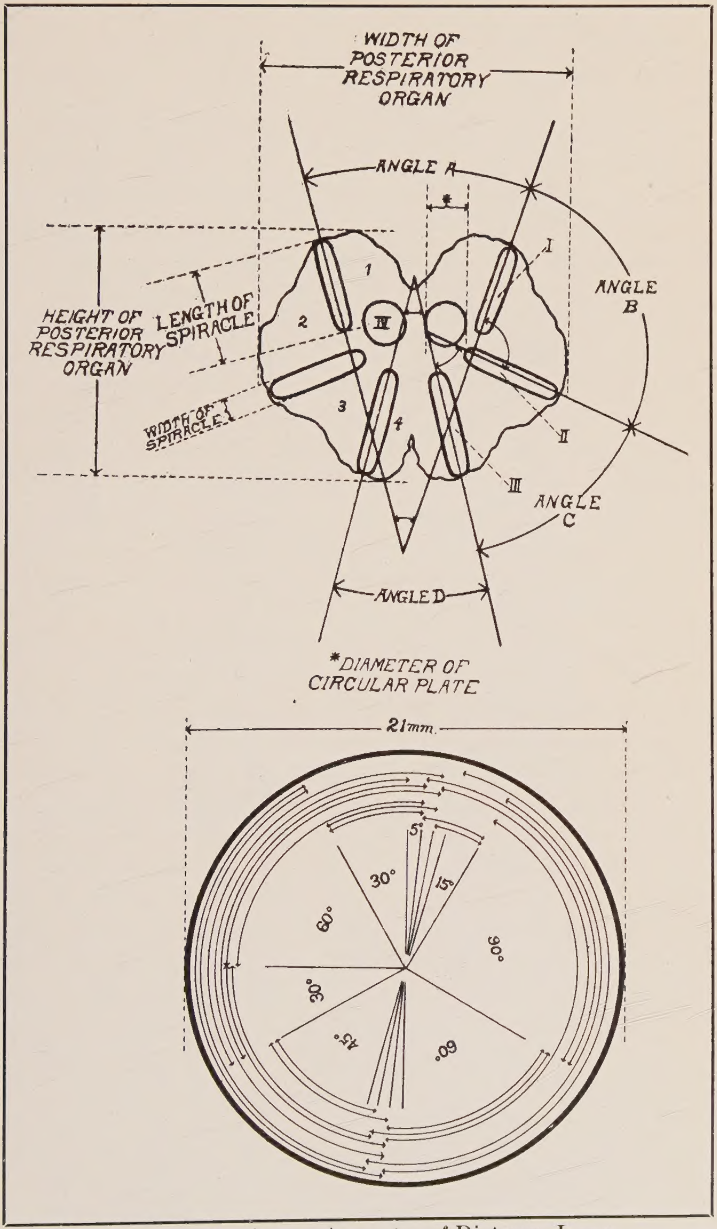
[1] Contribution from the Entomological Laboratory of the Massachusetts Agricultural College, Amherst, Mass.



METCALF—Respiratory Apparatus of Dipterous Larvæ.

reduced to a narrow transverse band in the tergal region of the Diptera, I have restricted the present discussion to the mesonotum alone, since it is usually well developed in most of the insects of this group.

In the mesonotum of the insects here discussed, there is a tendency for the prescutum ("psc," Figs. 1, 3, 5, and 6) to become prolonged further backward into the scutal region "sc," thereby becoming longer than broad, while in the lower insects it is frequently broader than long. On the other hand, the scutellum, "sl," which may become very narrow and prolonged far forward into the scutal region, "sc," in such lower insects as the Blattidæ, etc., in the insects here discussed tends to become somewhat broader than long. The mesothoracic postscutellum, "psl," is usually undeveloped in such lower insects as the Blattidæ, Mantidæ, Acrididæ, Dermaptera, Coleoptera, etc., but in the Embiidæ and Plecoptera it is quite well developed, as in the insects under consideration. The mesothoracic tegula "t" is frequently quite large in the insects under discussion, and is usually developed only in the mesothorax, while in the lower forms, it is usually small, or not developed in the mesothorax, although in some cases it may be developed in both meso and metathorax in the lower insects. The sclerite labeled "a" in Figs. 1, 2, 4, etc., is usually not well developed in lower insects, while in many of the higher insects it is quite large, its better development in the latter insects being probably correlated with the superior powers of flight in the higher forms. I have not observed the middorsal suture "ms" in many lower insects (excepting the Plecoptera and Embiidæ), while it appears to be present in many of the higher insects, although it is not present in all of them.

As may be seen from the accompanying diagrams (Plate II) the general plan of the sclerites is relatively simple, and is adhered to quite closely by most of the insects here shown. It is thus a much simpler matter to compare the different insects together in attempting to trace their paths of development than is the case with the wing venation, where the complex and intricate patterns, with their bewildering array of modifications, make it very difficult to trace out the paths of development followed by the different groups of insects, unless one has practically all of the intermediate stages; and even then he may be led astray by the study of only one set of structures, unless it be confirmed by an examination of many others from different parts of the body, since insects which are primitive in respect to one particular feature, may be relatively highly specialized with regard to certain other features, and the same set of structures is not always equally well developed in all insects. On this account, it has been a source of great surprise to me that those who attempt to trace the lines of development of insects confine their attention almost entirely to the difficult wing venation, neglecting other no less vital features (which due to their simpler arrangement are much easier to study), and they are apparently unmindful of the fact that, due to the different degree of development of a set of structures in different insects, no *one* set of structures can be relied upon for such a study, since the evidence must be drawn from *all available sources*, the evidence drawn from one source merely serving to check that drawn from other sources. On this account, I would present the evidence furnished by a study of the terga and wing bases as merely a portion of the evidence of relationships based upon the study of as many and as widely differing structures as possible, in an effort to determine the lines of descent and the interrelationships of the insects comprising the superorder "Panneuroptera."

The Neuroptera appear to be as primitive as any of the insects here considered, and a study of their structures may therefore be taken as the basis for that of the other forms, although the Neuropteron shown in Fig. 5 is not as primitive as the Sialidæ, etc., and was chosen largely to illustrate the tendency among certain Neuroptera toward the development of the type of tergum and wing base occurring in some Mecoptera and Diptera. In the Neuroptera (Fig. 5) the prescutum "psc" and scutellum "sl" tend to assume a triangular outline, and the apices of the triangles approach each other near the middle of the tergal plate in which these sclerites occur. The same tendency is apparent in the sawflies (Fig. 1) and in both sawflies and Neuroptera the prescutum "psc" (Figs. 1 and 5) is divided by the middorsal suture "ms" into two symmetrical halves.

As is indicated by the extent of the broad black line bounding the stumps of the cut off wings in Figs. 1, 2 and 4, the base of the wings is comparatively broad in the sawflies, Trichoptera, Lepidoptera, and lower Neuroptera, although in the Neuropteron shown in Fig. 5 this is not the case, due to the fact that it was chosen to illustrate the tendency in some Neuroptera for the wing base and tergum to approach the condition occurring in certain Mecoptera and Diptera. In both the Trichoptera (Fig. 2) and the Lepidoptera (Fig. 4) there is a marked tendency for the tegula "t" to become large—a tendency which is somewhat less developed in the Hymenoptera (Fig. 1) and in certain Neuroptera, although there are evidences of it in these insects as well. The tegula, however, is best developed in the Trichoptera and Lepidoptera, and in these insects the region labeled "s" (Figs. 2 and 4) is very similar in outline, as is true of the incision in the margin of the region immediately behind that labeled "s." In both Trichoptera and Lepidoptera (Figs. 2 and 4) the alar ossicle labeled "n" is comparatively well developed, as is also true of the sclerite labeled "a"; and in both Trichoptera and Lepidoptera, there is a marked tendency toward the formation of a membranous area "ma" (Figs. 2 and 4) in the postscutellar region "psl."

The above-mentioned similarities between the Trichoptera and Lepidoptera are in full accord with the evidence of close relationship drawn from other sources, such as the presence of a coiled proboscis in such Trichoptera as *Plectrotarsus gravenhorsti*, the lepidopteroid character of the venation and wing-outlines of certain Trichoptera, the similarity in the antennæ, legs, genitalia, outline of the abdomen, and other features which point very clearly to a community of descent, or a merging of the lines of descent of the Lepidoptera and Trichoptera as they are traced back to their point of origin; and (as has been pointed out in a paper soon to be published in the Trans. Ent. Soc. London, dealing with the phylogeny and interrelationships of the higher insects) these anatomical features of the adult insects, as well as the study of larval characters, clearly point to the Trichoptera rather than the Mecoptera as the stem forms from which Lepidoptera have sprung, despite the efforts of Handlirsch and Tillyard to emphasize the mecopteroid character of the venation of the lepidopterous wing. The Mecoptera are also related to the Lepidoptera, but less closely than the Trichoptera are, and I am more inclined to regard the lines of descent of the Mecoptera, Trichoptera, and Lepidoptera as springing off from a common point of a stem resembling the Neuroptera very closely, though the lines of descent of the Trichoptera and Lepidoptera appear to merge in a single line as we trace them back to this common point of origin.

The mesothoracic terga and wing bases of tipulid Diptera and the *Bittacus*-like Mecoptera are strikingly similar (Figs. 3 and 6). In both of these types of insects, the mesothoracic terga become very elongate, and the wing bases become shifted backward by the elongation of the prescutal region "psc" (Figs. 3 and 6). The wing bases are also rather narrow or constricted in these insects, as is indicated by the extent of the broad black line bordering the cut off wings in Figs. 3 and 6. A similar tendency is shown in the Neuropteron depicted in Fig. 5, and it is quite possible that the nemopterid Neuroptera resemble the common ancestors of Mecoptera and Diptera in some respects, especially in the evident tendency toward the elongation of the head region and the reduction of the hind wings to narrow ribbon-like structures, which is carried still further in the Diptera. The outline of the scutellum "sl" is very similar in the Dipteron and Mecopteron shown in Figs. 3 and 6, and the bulging region bearing the label "psl" in Fig. 3 apparently corresponds to the median region labeled "mt" in Fig. 6. The sclerites designated as "prt" in Fig. 3 probably correspond to those bearing the same label in Fig. 6. The prescutal region "psc" tends to assume a similar outline in both insects, the tegula "t" is small in both, and the alar ossicle "n" is not greatly developed in either of these insects. The outline of the tergum, and the nature of the wing bases as well as the features mentioned above would indicate a close relationship between the tipulid Diptera and the *Bittacus*-like Mecoptera, and this is borne out by the nature of the head, antennæ, mouthparts, legs genitalia and character of the abdomen in the two groups, so that the marked similarity in appearance between *Bittacus* and the lower Diptera is not merely a superficial resemblance, but extends to the more minute details as well. I would therefore maintain that the lines of development of the Mecoptera and Diptera merge as we trace them back to their common origin, and the Neuroptera appear to be as much like the common stock as any other insects, from which the lines of development of the Trichoptera and Lepidoptera, and the Mecoptera and Diptera, have sprung.

The tergum of the Hymenoptera (Fig. 1) is as much like that of the Neuroptera (Fig. 5) as any, and in general, the Hymenoptera seem to be quite closely related to the Neuroptera. The line of development of the Hymenoptera therefore probably arose near the base of the neuropteroid stem, though the Hymenoptera are in some respects intermediate between the Neuroptera and the Psocidæ. The Hymenoptera have many characters suggestive of affinities with the Mecoptera, although the Mecopteron shown in Fig. 3 is not so well suited as *Panorpodes* and other primitive Mecoptera for demonstrating this relationship. Since the mecopteron line of development originated at a point quite far down on the main neuropteron stem, it is merely to be supposed that the Mecoptera will show evidences of a rather close relationship to the Hymenoptera, which also occupy a position far down this main stem, and similarly, since the Trichoptera branched off from this main stem very near the point of origin of the Mecoptera, both Trichoptera and Mecoptera show indications of affinities with the Hymenoptera as well as with the Neuroptera; but the resemblances between the Hymenoptera, Mecoptera and Trichoptera are the most patent in the larval stages of these insects. Since the Hymenoptera resemble Mecoptera in some respects, and since the Diptera also resemble Mecoptera in many respects, it is to be expected that there will be certain points of resemblance between the Hymenoptera and Diptera also; but I do not consider that the Hymenoptera and Diptera are as closely related as MacGillivray and other students of the wing venation have been led to suppose, from their studies of this one set of structures alone. That the Siphonaptera (the fleas) were descended from Diptera-like ancestors is admitted by practically all recent investigators; but since these forms are wingless, it has not seemed advisable to include a study of their terga in a paper dealing largely with the wing-bases.

The evidence of relationships among the insects here discussed, as indicated by a study of the terga and wing bases, is in full accord with the evidence from other structures as well, and the conclusions here reached may be briefly summarized as follows. The Neuroptera are as primitive as any representatives of the superorder (the Panneuroptera), and probably have departed as little as any from the condition typical of the forms ancestral to the group as a whole. The Hymenoptera are also very primitive, and occupy a position far down on the main neuropteroid stem. The Mecoptera and Trichoptera arose from neuropteroid ancestors, and are also related to the Hymenoptera. The line of development of the Diptera merges with that of the Mecoptera, and the line of development of the Lepidoptera merges with that of the Trichoptera as all of these are traced back to the common neuropteroid stem. The Trichoptera are probably a little more closely related to the Neuroptera than to the Mecoptera, but their line of descent branched off from the common neuropteroid stem very near to the point of origin of the mecopteron line of development on the same neuropteroid stem. There are some reasons for regarding the Mecoptera as the stem forms from which the lines of development of the Diptera, Trichoptera and Lepidoptera have sprung; but the Neuroptera are on the whole as near as any, to the ancestral forms from which all of these insects are descended.

ABBREVIATIONS.

a. = Adanal process or ossicle (adanale).
j. = Juxtategula.
m. = Median ossicle (medipterale).
ma. = Membranous area of postscutellum.
ms. = Middorsal suture.
mt. = Meditergite.
n. = Notopteral ossicle (notopterale).
pa. = Prealar bridge (prealare).
pf. = Prescutal fontanelle.
po. = Posttergite.
prt. = Pretergite.
ps. = Parascutellum.
psc. = Prescutum.
psl. = Postscutellum.
pt. = Paralegula.
ptg. = Postalare or pleurotergite.
s. = Suralare.
sc. = Scutum.
sl. = Scutellum.
so. = Scutal organ.
t. = Tegula.

EXPLANATION OF PLATE II.

Fig. 1. Mesonotum and wing-base of the Hymenopteron *Cephaleia*.

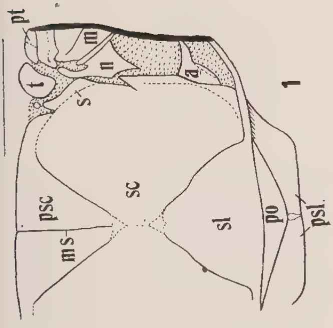
Fig. 2. Mesonotum and wing-base of the Trichopteron *Neuronia*.

Fig. 3. Mesonotum and wing-base of the Mecopteron *Bittacus*.

Fig. 4. Mesonotum and wing-base of the Lepidopteron *Phassus*.

Fig. 5. Mesonotum and wing-base of the Neuropteron *Nemoptera*.

Fig. 6. Mesonotum and wing-base of the Dipteron *Tipula*.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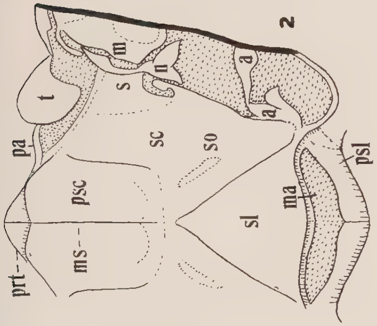
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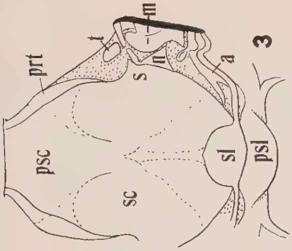
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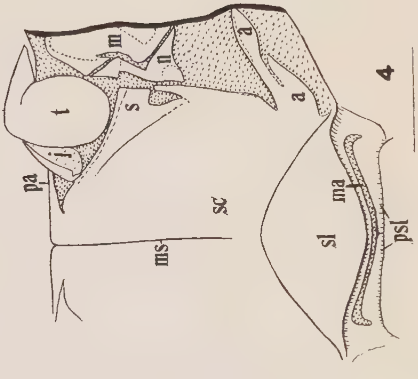
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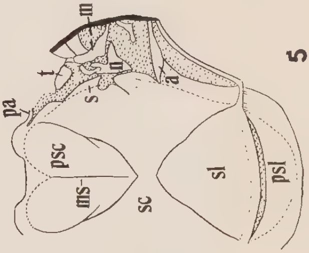
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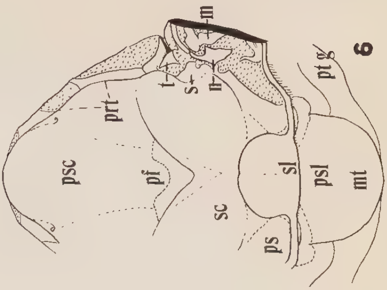
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Crampton—Mesothoracic Terga and Wing-Bases.

A LIST OF DRAGON-FLIES COLLECTED AT WAREHAM, MASS., DURING THE YEARS 1911 TO 1913 BY MR. OUTRAM BANGS.

By R. Heber Howe, Jr.
Thoreau Museum of Natural History, Concord, Mass.

The following rather remarkable list of Odonata is the result of my determination of a collection made by Mr. Bangs at Wareham, Massachusetts, and the material on which it is based is now distributed through the general collection of the Museum of Comparative Zoölogy, Cambridge, Mass. Access to the specimens was obtained through the kindness of Mr. Nathan Banks, and permission to publish the list secured from both Mr. Banks and Dr. Samuel Henshaw. Several duplicates are in the author's collection, and that of the Boston Society of Natural History.

Though Mr. Bangs is not familiar with the group Odonata his trained naturalist's eye made it possible for him to collect a very large percentage of the species that occur, and the list is deficient only in the Zygoptera or smaller Damsel-flies. Mr. Bangs has provided annotations of several interesting species.

Zygoptera.

1. *Agrion æquabile* (Say). "Occurs only, so far as I know, along Eagle hill river. I got one."
2. *Agrion maculatum* Beauv. June 2–9. Several specimens.
3. *Lestes eurinus* Say. June to July 30. Several specimens.
4. *Lestes unguiculatus* Hagen. One specimen.
5. *Lestes rectangularis* (Say). June 28 to July 30. Several specimens. I collected it at Monument Beach.
6. *Lestes vigilax* Hagen. July 30. One specimen. I collected it at Wareham in 1917.
7. *Lestes inequalis Walsh.* Aug. 12. One specimen.

Note: I collected *Lestes forcipatus* Rambur., in the nearby town of Monument Beach.

8. *Argia violacea* (Hagen). July 5 to Sept. 4. Several specimens. I collected it at Wareham in 1917.
9. *Enallagma durum* (Hagen) June to Aug. 3. Several specimens. This is the most northern station for this species.

10. *Enallagma traviatum* Selys. July 8. One specimen.
11. *Enallagma civile* (Hagen). I collected this species at Wareham in 1917, and Mr. Bangs has one doubtful specimen in his collection.
12. *Enallagma pictum* Morse. July 8 to 30. Two specimens. This is the second New England record for this species, and the most northern station for it.
13. *Enallagma signatum* (Hagen). Aug. 3. One specimen.
14. *Amphiagrion saucium* (Burm.). Aug. 3. Several specimens.
15. *Ischnura verticalis* (Say). June to July 10. Several specimens. I collected the species at Monument Beach in 1917.
16. *Anomalagrion hastatum* (Say). July 10. Several specimens.

Anisoptera.

17. *Cordulagaster diastatops* Selys. June 17. One specimen.
18. *Progomphus obscurus* Ramb. July 5 to 29. Several specimens. Not uncommon in the oak scrub Mr. Bangs tells me. This is the second New England Station for this species.
19. *Hagenius brevistylus* Selys. July 8. "Local, usually seen along cranberry bog ditches and brooks." This is the most southern latitudinal record for the species.
20. *Gomphus exilis* Selys. July 5 to 8. Two specimens.
21. *Dromogomphus spinosus* Selys. July 29 to Sept. 1. Several specimens.
22. *Boyeria vinosa* (Say). June to Aug. 15. Two specimens.
23. *Basiæschna janata* (Say). May 31. One specimen.
24. *Anax junius* (Drury). June 17 to Sept. 20. Several specimens
25. *Anax longipes* Hagen. "Seen three or four times always over ponds. Hard to catch." Mr. Bangs is sure that his determination is correct. This is the second New England station for the species.
26. *Æshna canadensis* Walk. Aug. 16 to 20. Several specimens.
27. *Æshna clepsydra* Say. Aug. 7. One specimen.
28. *Æshna umbrosa* Walk. Aug. 23 to Sept. 11. Several specimens.
29. *Epiæschna heros* (Fabr.). Sept. 20. One specimen.
30. *Macromia illinoiensis* Walsh. July 27. One specimen.

31. *Epicordulia princeps* (Hagen). July 3 to 26. "Common at times."
32. *Tetragoneuria cynosura* (Say). May 3 to Aug. 3. Several specimens.
33. *Tetragoneuria cynosura simulans* Mutt. May 3 to July 9. Several specimens.
34. *Dorocordulia lepida* (Hagen). June 28 to Aug. 3. Several specimens.
35. *Somatochlora tenebrosa* (Say). Aug. 2 to 7. Several specimens.
36. *Libellula* (*Ladona*) *exusta* Say. May 7 to July 9. Several specimens.
37. *Libellula auripennis* Burm. July 4 to 30. Several specimens.
38. *Libellula cyanea* Fabr. June 28 to Aug. 7. Several specimens. The females of the series approach very closely *L. flavida* Will.
39. *Libellula incesta* Hagen. July 6 to Aug. 5. Several specimens. One specimen shows a slight approach to *L. flavida* Williamson in the number of subtriangle cells.
40. *Libellula pulchella* Drury. June 20 to Aug. 8. Several specimens.
41. *Libellula quadrimaculata* Linn. May 31 to June 28. Several specimens.
42. *Libellula semifasciata* Burm. May 3 to Aug. 7. Several specimens.
43. *Plathemis lydia* (Drury). May 31 to July 5. Several specimens.
44. *Perithemis domitia tenera* (Say). July 18 to Aug. 9. Several specimens.
45. *Nannothemis bella* (Uhler). July 8. Several specimens.
46. *Erythrodiplax berenice* (Drury). July 8 to 10. Several specimens. Confined to salt marshes.
47. *Erythemis simplicicollis* (Say). July 8 to 30. Several specimens.
48. *Sympetrum costiferum* (Hagen). Aug. 6. One specimen.
49. *Sympetrum rubicundulum* (Say). June 17 to July 30. Several specimens.
50. *Sympetrum semicinctum* (Say). July 30 to Aug. 7. Several specimens.
51. *Sympetrum vicinum* (Hagen). June. One specimen.

52. *Pachydiplax longipennis* (Burm.). June 7 to Aug. 6. Several specimens.
53. *Leucorrhinia frigida* Hagen. June to Aug. 11. Several specimens. This is the most southern station for this northern species.
54. *Leucorrhinia intacta* Hagen. June 9. Several specimens.
55. *Celithemis elisa* (Hagen). July 26 to Aug. 11. Several specimens.
56. *Celithemis eponina* (Drury). July 8 to Aug. 16. Several specimens.
57. *Celithemis monomelæana* Will. July 8 to Aug. 14. Several specimens. This is the most northern and second New England record and station for this rare southern species.
58. *Celithemis ornata* Ramb. July 2 to Aug. 14. Several specimens.
59. *Pantala flavescens* (Fabr.). Aug. 9. One specimen.
60. *Tramea carolina* (Linn.). June to July 30. Several specimens.

NOTE ON THE GENUS LIOBRACON, WITH THE DESCRIPTION OF A NEW SPECIES (HYMENOPTERA; BRACONIDÆ).

By Charles T. Brues,

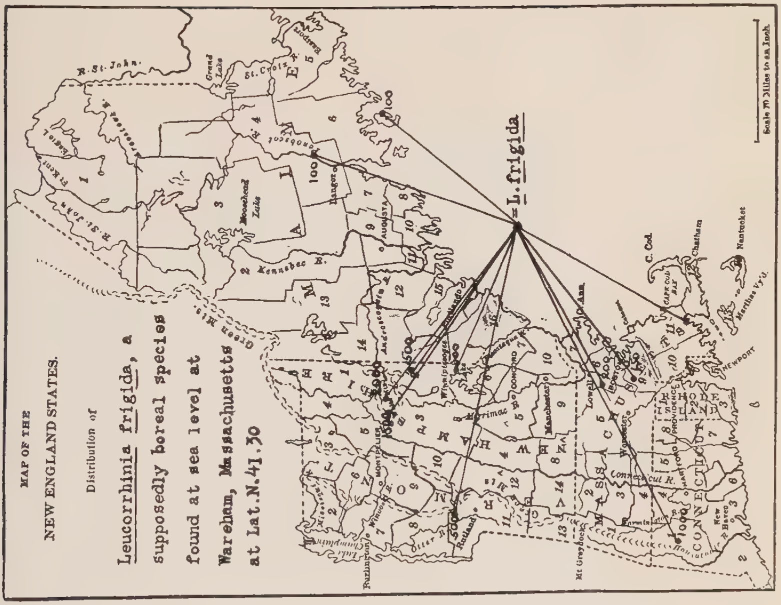
Bussey Institution, Harvard University.

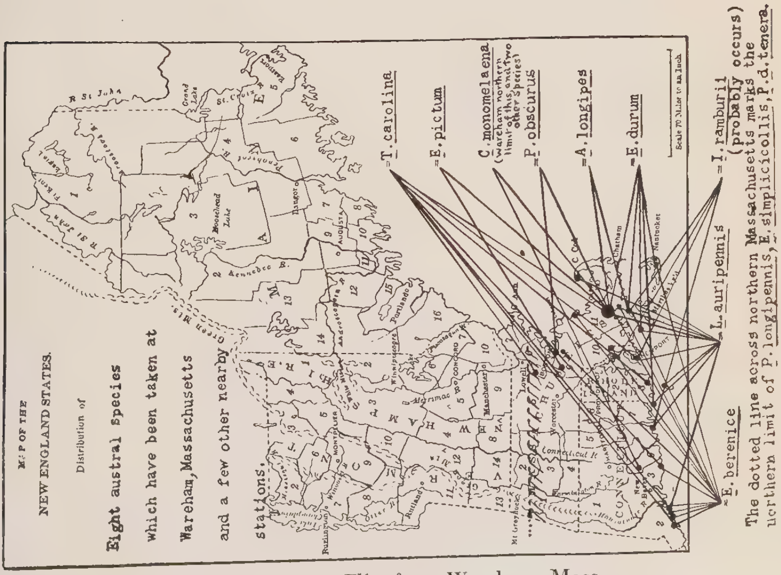
In a small collection of Parasitic Hymenoptera collected in Hayti several years ago by Dr. William M. Mann, I have found several specimens of the insect described by Cresson as *Bracon distinctus* in his "Hymenoptera of Cuba." This proves to belong to the genus Liobracon Szépligeti, to which several South American species have hitherto been referred. In addition there is a second species taken by Dr. Mann which is described below.

Liobracon Szépligeti.

Termes Füzetek, Vol. 24, p. 361. (1901.)
Gen. Ins., fasc. 22, p. 66. (1904.)
Type *L. macula* Brullé (*singularis* Szép).

The species may be distinguished as follows:





The dotted line across northern Massachusetts marks the northern limit of P.longipennis, E.simplicicollis, P.d.tenera.

HOWE—Dragon-Flies from Wareham, Mass.

1. Wings fuscous or black 3
   Wings flavous, marked with black 2
2. Wings with two black bands . . . . *geniculatus* Brullé
   Apical half of wing black . . . . *partitus* Enderlein
3. Stigma black 3
   Stigma yellow; legs red and black; scutellum bifoveate at base . 4
4. Pronotum and propleura smooth; thorax and middle of hind femora red; scutellum bifoveate at base . . . . *cressonii* D. T.
   Pronotum and most of propleura rugose-reticulate; thorax and legs entirely black; scutellum with a crenate furrow at base. . . . . *manni* sp. nov.
5. Antennal flagellum black; second suture of abdomen weakly crenulate . . . . *macula* Brullé
   Antennal flagellum dark red; second suture smooth *ruficornis* Cam.

Liobracon manni sp. nov.

♀. Length 9 mm. Ovipositor nearly as long as the abdomen. Black, including the wings entirely; abdomen bright red; body clothed with long and very sparse white hairs. Head as thick as broad, distinctly, but not strongly margined behind; eyes prominent, temples broad, widened behind the eyes. Front impressed, the depression extending around the ocellar tubercle, with a median carina between and just above the antennæ, but without punctures. Head above smooth and shining; face rugose-reticulate at the sides, rugose below, with an elongate median smooth tubercle. Malar space half the height of the eye, without furrow; head behind with a few very fine punctures. Antennæ as long as the body; scape twice as long as thick, not noticeably swollen; flagellar joints all nearly three times as long as thick, first not noticeably longer than the second, following three or four scarcely decreasing in length. Pronotum rugose-reticulate with a transverse groove at the extreme posterior margin. Mesonotum smooth and polished except for a few coarse punctures medially behind; parapsidal furrows smooth, very deep, the median lobe strongly elevated anteriorly with its surface rising vertically behind the prothorax. Scutellum smooth, flat, at the base with a broad furrow composed of eight elongate foveæ. Propodeum covered with scattered round impressions; these are well-separated, of about equal size, each somewhat smaller than one of the ocelli; medially with two closely approximate, punctate, grooved lines. Prosternum with sparse, rather large punctures; mesosternum smooth. Propleura closely, irregularly punctate below, above which is a coarsely, transversely, striate impression; upper angle with some irregular, coarse sculpture. Mesopleura smooth, convex, except for a furrow next the tegula, a broader one not far below the first and a deep foveate impression at the middle just before the posterior edge. Metapleura with scattered, setigerous punctures; spiracle small, nearly round; subspiracular groove very finely impressed. Abdomen as long as the thorax, subacute at tip and much swollen at the middle; first segment with four short carinæ at base, the lateral ones close to the margin, its surface with a few poorly impressed large punctures, more noticeable laterally; median portion nearly flat; second and following segments entirely smooth; second with its middle portion, defined by a punctate line, broadly transversely oval, more than twice as wide as long; from the side of this an oblique punctate furrow extends backward to the margin and another one directly forward, these defining a large side piece and a small triangular depressed area at the anterior edge between the sidepiece and the central oval space; corners of following segments not distinctly separated; hind margin of third segment weakly sinuate. Legs very stout; middle and hind tarsi no longer than their tibiæ; tibial spurs very short; claws simple; front tibiæ with a row of stout spinules on the front side. Radial cell ending considerably before the wing tip, third section of radius nearly twice as long as the other two together; second more than twice as long as the first and scarcely longer than the second transverse cubitus; submedian cell longer than the median by nearly the length of the nervulus which is very slightly oblique; parallel vein originating at the lower corner of the third discoidal cell; recurrent nervure entering the first cubital cell far before the apex; second cubital with almost parallel sides and weakly narrowed above. Radial cell of hind wing without indication of a cross-vein, the discoidal vein (originating at the lower end of the basal vein) not transverse except at base, sharply bent and extending toward the apex of the wing.

Type from St. Marc, Hayti.

Although very similar to *L. cressonii*, this species differs noticeably in the sculptured pronotum and punctate furrows on the second abdominal segment, as well as in the plainly undivided radial cell and curved discoidal vein in the hind wing.

Liobracon cressonii D. T.

Cresson, Proc. Ent. Soc. Philadelphia, Vol. 4, p. 75. (1865.) (*Bracon distinctus.*)

Dalla Torre, Cat. Hym., Vol. 4, p. 264. (1898.) (*Bracon cressonii.*)

Dr. Mann took this species in Hayti at Cape Haytien, Grand Rivière and St. Marc.

SOME OBSERVATIONS ON THE WEBBING CLOTHES MOTH (*TINEOLA BISELLIELLA* HUM.).[1]

By M. T. Smulyan,
U. S. Bureau of Entomology, Melrose Highlands, Massachusetts.

Two larvæ, 7 and 11 mm. long, respectively, discovered working in the writer's overcoat October 25, 1917, were placed in a glass jar lined, except at the top, with a layer of gray felt, and placed in his sleeping room where his clothes-closet was located, for rearing and observation. The room was then receiving, and continued to do so until well into April, some furnace heat during the day, but was quite cool during the night and early forenoon, when it was freely ventilated. Owing to the writer's regular duties, most of the observations dealing with the behavior of the larvæ were made at the close of the day, by artificial light—which, as will be seen below, may have had a bearing on the behavior of one of them.

October 28, both larvæ feeding freely. November 1, the smaller within a substantial cocoon, at the bottom of the jar. November 2, had moulted—found the cast shell of the head just outside the cocoon, at one end, and the remainder of the skin just outside at the opposite end—but when the jar was brought closer to the light (gas) in order to verify the observation, the larva hurried out of the cocoon and crawled away. November 4, the same individual in the process of constructing another cocoon; the other—the larger—was still feeding freely. November 7, found the latter encased in a cocoon at the bottom of the jar beneath the felt, next to the glass. The underside of the cocoon was incomplete and the larva was in part visible through the glass. November 11, conditions about unchanged. November 14, larva within cocoon beneath felt had moulted (skin disposed as in the case of the other); soon after it became comatose and remained so, as far as could be observed, until the following May. November 18, the remaining and active individual was still at cocoon-making, but this time in still another location—at the bottom of the jar beneath the felt. November 21, could not be located, but when jar was brought closer to the light to facilitate the observation it came out of one of the previously constructed cocoons. November 25, within a more or less incomplete new cocoon, close to the one which it forsook the 21st. November 28, had moulted again; came half way out of cocoon during observation but backed in again. December 2, left cocoon during observation. December 5, again within one of its former cocoons, and forsook it while observation was made. December 9, moving about freely. December 12, ditto. December 16, within a rather loosely-constructed cocoon on bottom of jar, beneath felt, like its comatose companion. December 19, cocoon more dense. December 24, had moulted once more—third time since its confinement. December 30, apparently comatose. Both larvæ, it should be said at this point, moulted once, in addition, after they had apparently become torpid, just when the writer cannot say, the cast skins, evidencing this, being found in the cocoons—at the hinder ends—the following spring, after the emergence of the adults. It is interesting to note that in the final moult the cephalic portion of the skin remains attached to the rest of the skin; the dorsal or upper surface of the former splits medianly and longitudinally and the larva either wriggles out, or else pushes the skin off over its anal end. The interior of the cocoons are lined with white silk.

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[1] Identity of species verified by Mr. August Busck of the U. S. Bureau of Entomology, Washington, D. C.

The moth which developed from the more active larva emerged first and proved to be a male. It was first observed May 14 (1918). It died May 23. The other moth (female) emerged between May 24, and May 26. In both cases, the empty pupal skin projected in greater part beyond the end of the cocoon, as figured by Riley (Ins. Life, II, 1890).

Eggs were observed June 2, a. m., and they were numerous then, None were observed May 31. Oviposition continued to June 8, p. m., at the latest, and the total number counted was 99—51 up to June 2, a.m., 41 between 2, a.m. and 4, p.m., 7 between 4, p.m. and 8, p. m. They were laid on the less compact or looser surface of the felt, and some were placed quite deeply among the loose fibers. Evidently they are not always placed singly, for in one instance a group of four was found, and several occurred in pairs. The moth died the evening of June 9. The eggs (infertile in this case) were white to the unaided eye and under an ordinary hand lens, but practically colorless when magnified more highly; oval to ovoid in shape, but a few were somewhat reniform, resembling a type of bean; surface somewhat roughened, marked with nearly spherical, squarish, or elongate shallow depressions, with very narrow intervening ridges. Whether the roughened surface, and the subreniform shape, was due to the age of the eggs—for on June 9, when they were examined, a large proportion had already collapsed—the writer cannot say, although, he might state, it did not appear so. Eighteen were measured and were found to be .49 to .66 mm. long and .27 to .34 mm. wide. The longest were generally the broadest.

The present record, it might be added, adds to the accumulating evidence, seemingly, that this species rather than *Tinea pellionella* Linn. (the case-making moth) is the more common species in the North.

How is the marked difference in degree of activity and sensitivity manifested by the larvæ to be explained? Is it a matter of individuality? Or, in view of the resulting difference in sex, is it a matter of sex?

ECOLOGICAL RELATIONS OF THE LEPIDOPTEROUS GENUS DEPRESSARIA (ŒCOPHORIDÆ).

By Miss Jay R. Traver,
Department of Entomology, Cornell University.

The members of a group of animals or plants, closely allied to one another in a systematic sense, may yet differ rather widely in their habits of life. While fitted for the same general type of environment, they nevertheless show considerable variation in their adaptations to certain phases of that environment. Especially is this true of the ways in which they obtain the two prime necessities of life—food and shelter. The genus Depressaria, of the Lepidopterous family Œcophoridæ, illustrates such variation of habits. As regards this rather large genus, many facts of a biologic nature remain still to be worked out. However, from the data available, some interesting ecological relations have been noted.

In treating this genus, the catalogues of Staudinger and Rebel for European forms, and of Dyar for North American forms, have been followed, with additions of such as have been described since these publications, and of such exotic forms as are given in a few other sources. From the British Museum Catalogue, seven species are listed for which no references could be found. These are *D. acerbella*, Africa, a doubtful member of the genus; *lewinella*, *melesella*, *sobriella*, *convictella* and *absumptella*, Australia; and *moderatella*, Tasmania. If these species have been transferred from Depressaria, no account of such transfer could be found. From Cotes and Swinhoe's *Moths of India*, seven species are listed, omitting *D. gossypiella*, which is no longer placed in this genus. One species is also listed from the Biologia Centrali-Americana.

The genus as here treated consists of two hundred and forty-nine species, distributed throughout most parts of the world, yet occurring mainly in Central Europe. The table of distribution is as follows:

North America	48	Russia and the North Countries	27
Central America	1	Japan	1
South America	3	China	1
British Isles	19	India	9
Central Europe	102	Rest of Asia	30
Southern Europe	59	Africa	11
Spain and Portugal	24	Australia	7

If the grouping be given for continents, Europe has by far the greatest number, and these are in the main located in central Europe. Stainton says: "Though most of the European species seem to be widely distributed, a few are restricted to the south, and some are peculiar to the north." It is evident that this statement still holds good, though the number of recognized species is now nearly three times that known by Stainton.

Of these two hundred and forty-nine species, the life-histories of ninety-four are recorded. H. T. Stainton has probably given us the most material, in a compact form but very comprehensive, in his *Natural History of the Tinenia.* In volume six of this work, he treats of the life-histories of twenty-four species, while in volume twelve he adds twelve more to the list. Chretien, likewise, among recent entomologists, seems to have devoted much time to life-history work among the smaller forms, and he has given us much valuable data of this sort for the genus Depressaria. Besides the thirty-six species treated by Stainton, fifty-eight others have been reared or otherwise studied by other workers, so that their habits are known. For one hundred and eighteen of the remaining species merely distribution and description, usually of adult alone, but occasionally of larva and pupa also, have been given. Complete references for thirty-three of these species were not available. The references to the rest of the species include likewise some mention of the food plant of the larva. That is to say, for 53 per cent. of the genus, something of the life-history and habits is known. Since an ecological study of a group depends mainly on such material as this, it is clearly impossible to give more than an estimate of that group, when so much remains to be determined. The tables given are, therefore, in no sense complete, but merely an arrangement of such biologic knowledge of the group as has been verified.

Ten of the species are known to be gregarious in their larval habits, a number of larvæ living together on the same leaf or in the same umbel. Twenty-two, however, are recorded as being solitary in the larval state, while no mention is made of the social habits of any of the others.

Of the seasonal distribution, no very definite facts could be learned. Several are known to pass the winter as imagos, a few as larvæ, and others in the egg stage. Mention is made by Chretien of one species, *D. halophilella*, which "lives during the winter in the interior of the stems, the shoots and the pulpy leaves of *Crithmum maritimus.*" It seems to be generally accepted that the genus is single-brooded and that the eggs do not hatch till rather late in the spring. In the case of those passing the winter in the imago form, it is several times noted that the adult insect is rarely seen in the fall, but more commonly in the spring after its hibernation.

Stainton writes of the adult insects: "The perfect insects of the genus Depressaria live very retired, and species may be excessively abundant, yet never seen in the perfect state. Many of the species hibernate in the perfect state, and some, which are seldom seen before hibernation, are comparatively common in the spring; but others do not show themselves either before or after hibernation." He further mentions that the adults may often be taken after dusk, on the food plants, when they are found crawling up the stems. "When dislodged from any place of retreat, they shuffle along with considerable rapidity till they have attained a fresh place of concealment." The adults are likewise mentioned by Stainton as being fond of sweets.

In the main the pupal state seems to be passed on or near the surface of the ground, usually under stones, dried leaves or other rubbish. Thirty-nine are reported as pupating thus, usually within a light silk cocoon. But there are others that remain in the top of the plant for pupation, either in the umbels or in the silken webs in which they found shelter as larvæ; seventeen are recorded in this category. One of these remains within a silken gallery which it spun inside a leaf, the outer edges of which were drawn up and securely fastened. Still a third type of pupal habit is known, that of pupating within the stem of the plant. Three species belong here. One of these has been described as burrowing into the stem for a short distance, then up, after which it erects, across the hollowed stem and above the entrace hole, a silken platform, upon which the pupal state is passed.

The habits of the larva are perhaps of greater interest, as these are determined mainly by the need for food and shelter. Their methods of providing themselves with shelter may be considered first. Twenty-four are leaf-rollers, usually rolling part of the leaf and securing it with bands of silk, thus forming a shelter for themselves when they are at rest. Twenty-three are makers of tubes, either wholly of silk, or more often partly of leaves or flower heads and partly of silk. Within this tube they find safety. Still others, fifty-seven of which are recorded, may be called web spinners, since they form irregular webs, and with these silken strands draw leaves of a shoot or flower-heads in an umbel more or less together; or perhaps merely parts of a leaf are thus held and fastened. Some larvæ are both web spinners and tube makers or leaf rollers. Three are known to be leaf miners, at least in the earlier stages of their larval life. Five others are stem borers during their lives as larvæ.

The majority of the larvæ feed upon the leaves of their respective food plants. Packard writes: "The larvæ are extremely active and feed on a variety of substances; some in rolled-up leaves of composite plants, some in the leaves and others in the umbels of umbelliferous plants." Sixty-seven are recorded as leaf-feeders. One feeds partly upon bark and twigs. Of the six which bore into stems, in only one case was mention made of the part of the plant fed upon; in this, the larva fed on the stem. Hence it is doubtful whether the other five may be considered to be stem feeders, or whether they merely obtain shelter from the hollowed stem, coming forth to feed upon other parts of the plant. Eighteen feed upon the buds or flowers, while four others feed upon the fruit also, after the flowers are gone. This distribution leaves practically no part of the plant, except the root, which members of this genus do not use for food.

Stainton writes: "The food of the larvæ is very various, some of them feeding on the leaves of composite plants, others, and by far the greater portion, in the umbels or on the seeds or leaves of different species of Umbelliferæ; again the larvæ of two species feed on the sallow, whilst the *Hypericum perforatum* affords a pabulum to another species." Sixteen different plant families are represented among the food plants of the larvæ of this genus. Of these, Umbelliferæ easily takes the lead, furnishing fifty-nine species of larvæ with food. Compositæ stands second only in favor among this group, with thirty-three larvæ feeding upon it. Leguminoseæ are fed upon by eleven species, Cupuliferæ by four and perhaps five. In one instance note was made of the fact that the imago was taken from an oak, which probably means that the larvæ of that species feed upon the oak. Five are known to feed upon Rutaceæ, two upon Euphorbiaceæ, two upon Hypericaceæ, two upon each of the families of Salicaciæ and Coniferæ, while the families Cistaceæ, Lythraceæ, Rosaceæ, Burseraceæ, Malvaceæ, Rhamnaceæ and Polygonaceæ are likewise represented, one species of larva being recorded from each of these families.

Only three of the genus are known to be of economic importance, *D. heracliana* is known as the parsnip web-worm, and an account of its depredations, with methods of control, may be found in

Sanderson's Insect Pests (p. 417). *D. groteella*, feeding upon hazel and *D. robiniella* upon locust, are both at times injurious to forest trees. Accounts of these may be found in Packard's Insects Injurious to Forest Trees, with methods of control should the larvæ become a pest.

The following is a summary of what is now known of the habits of the genus:

Social habits.	
Gregarious	10
Solitary	22
Hibernation.	
As egg	3
As larva	4
As adult	19
Feeding habits.	
On leaves	67
On buds or flowers	18
On bark or twigs	1
On stem	6
On fruit	4
Economic importance.	
D. groteella	on hazel
D. robiniella	on locust
D. heracliana	on parsnip
Methods of obtaining shelter.	
Leaf rollers	24
Tube makers	23
Web spinners	57
Leaf miners	3
Stem borers	5

Pupation.	
On ground	39
In umbels or leaves	17
In stem	3
In gallery	1
Food plants.	
Umbelliferæ	59
Compositæ	33
Leguminosæ	11
Cupuliferæ	5
Rutaceæ	5
Euphorbiaceæ	2
Hypericaceæ	2
Salicaceæ	2
Coniferæ	2
Cistaceæ	1
Lythraceæ	1
Rosaceæ	1
Burseraceæ	1
Malvaceæ	1
Rhamnaceæ	1
Polygonaceæ	1

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NOTES ON THE EARLY STAGES AND LARVAL LOCOMOTION OF *LEIA BIVITTATA* SAY[1] (DIPTERA).

By Harry B. Weiss,
New Brunswick, New Jersey.

Several specimens of this fungus gnat were bred during the last of March from the partly decomposed fruiting bodies of *Lenzites betulina*, which had been collected during February on an old stump at New Brunswick, N. J., and kept in a warm room. It is evidently a well distributed species as it was described by Say from Indiana, and Johannsen[2] records it from Connecticut, Rhode Island, North Carolina, Wisconsin, Illinois, Kansas, Minnesota, Iowa, Michigan and New York. In Aldrich's Catalogue of North American Diptera it is listed as *Neoglaphyroptera bivittata* Say, and Smith[3] records it under the same name from several points in New Jersey.

Full grown larvæ under observation averaged about 13 mm. in

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[1] Kindly identified by C. W. Johnson.

[2] Fungus Gnats of North America, Part III, p. 290, Maine Agric. Exp. Sta. Bull. 196.

[3] Insects of New Jersey, N. J. State Mus. Rept. 1909.

length and 1 mm. in width, each being apodous, subcylindrical, elongated, slightly tapering toward anterior and posterior ends, twelve-segmented, whitish, transparent showing tracheæ and alimentary canal, with dark brown or brownish-black oval head slightly retracted in first segment, and having eight pairs of spiracles protected by chitinized, conical projections, one pair on first segment and remaining pairs on first seven abdominal segments.

The pupa is about 5.5 mm. long, free, whitish, smooth, with legs applied to the breast and venter, the antennæ bent around the eyes and extending between the wings and legs and with six pairs of distinct abdominal spiracles and each prothoracic spiracle located behind the antenna and above the root of the wing. The pupa is suspended and surrounded by a network of threads which can hardly be called a cocoon. This stage requires only four or five days. Hibernation evidently takes place in the partly grown larval condition and the larvæ resume feeding and pupate during the spring. Both the larvæ and pupæ are very similar to those of many other members of the family Mycetophilidae as treated by Williston,[1] Johannsen[2] and Osten Sacken.[3]

The locomotion of the larva is peculiar and interesting. To begin with, the larva is completely clothed except for the head, in a transparent, elastic mucus-like, skin or film, which conforms to the shape of the larva and which is as a result somewhat like a tube or tunnel. When the larva desires to move over the fungus, it stretches its head forward and to one side and fixes the tip of a drop of viscous matter from its mouth to the surface of the fungus. The head is then withdrawn and raised somewhat, the withdrawal resulting in the drop of viscous matter being pulled out into a thread and the raising allowing the remainder of the drop in the larva's mouth to slide back along the outer lower side of the first segment to be added to the mucus envelope already covering its body. It then stretches its head to the other side, sometimes slightly more forward and repeats the operation. This is kept up as long as it continues to move, the larva thus covering itself with a mucus tube through which it slides and anchoring or mooring this tube to the surface over which it moves by somewhat elastic, lateral threads, there being from five to nine placed on each side over every distance equal to its length. These threads are at times opposite each other but are more often somewhat alternate.

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[1] Manual of North American Diptera.

[2] Fungus Gnats of North America, Parts I, II, III, IV, Maine Agric. Exp. Sta. Bulls. 172, 180, 196, 200.

[3] Characters of the Larvæ of Mycetophilidae, Proc. Ent. Soc. Philadelphia, 1862.

As the larva moves forward, the mucus tube collapses behind its posterior end and remains as a flat, glistening trail. This trail is more or less broken and ragged in places; sometimes the anchoring threads break and sometimes the empty tube breaks as the larva travels in and out and over and around obstructions, etc., in its path. In fixing its mooring threads and building or adding to its transparent covering the larva moves its head in a quick, jerky fashion and altogether can glide along fairly rapidly. Excrement, particles of fungus and other foreign matter which adhere to the tube as the larva works in the fungus remain stationary and the larva simply slides under them.

Sometimes, but apparently not often, the larva reverses its forward motion and slides backward for a short distance filling the collapsed portion of the tube again. When it reaches its desired position, it bites through the portion covering its head and starts off in a new direction. If, in its forward movement, it has misplaced its mooring threads, it bites through them thus releasing the anterior part of its tube. In this manner it travels over and in the fungus feeding as it goes.

Before pupating, larvæ under observation anchored their tubes in spaces between pieces of fungi in the cage using quite a few more supporting threads for this operation than they used in anchoring their tubes while moving and so placing them that the tube and later the pupa was suspended in a network and did not touch any part of the fungus. These threads were not numerous or close enough, however, to even slightly resemble a loosely built cocoon.

According to Perris[1] the larva of *Sciophila unimaculata* moves in a similar way. An interesting account of the habits of this species, which Perris found associated with the fungus *Polyporus versicolor*, together with descriptions and figures of the larva and pupa is given in his paper, "Note pour servir à l'histoire de la *Sciophila unimaculata* Macq."[2]

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[1] Ann. Soc. Ent. France 2; 7; p. 341–50, 1849.

[2] Loc. cit.

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